

Experimental Validation of the Gamma Spectrum Generator Results



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Outline

- **Point gamma-sources (GSG)**
- **Shielded point-like gamma-sources (EMC+GSG)**
- **Shielded volume gamma-sources (EMC+GSG)**

Experimental validation with 60% HPGe coaxial detector (INR, Kiev)

Detector: coaxial HPGe (Canberra)

- Relative efficiency: 61.8%
- Crystal dimensions: $\varnothing 74 \text{ mm} \times 53 \text{ mm}$
- Rear contact: $\varnothing 10 \text{ mm} \times 36 \text{ mm}$
- Inactive Ge: 0.7 mm
- Crystal end cap: 1.5 mm Al
- End cap to crystal gap: 5 mm
- FWHM: 1.75 keV at 1.33 MeV

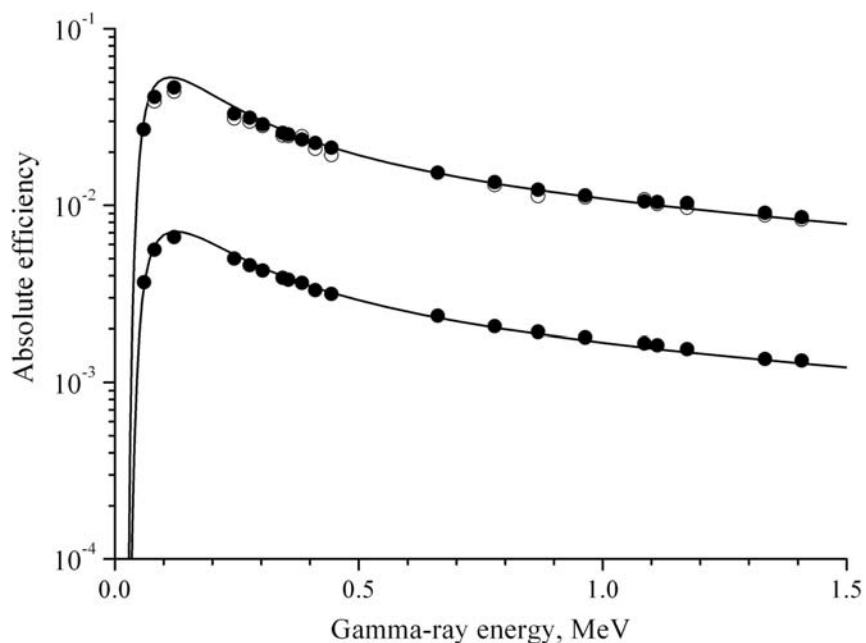
Sources: Thin Spectroscopic Reference Gamma-Sources (SOSGI)

- ^{137}Cs , ^{60}Co , ^{152}Eu

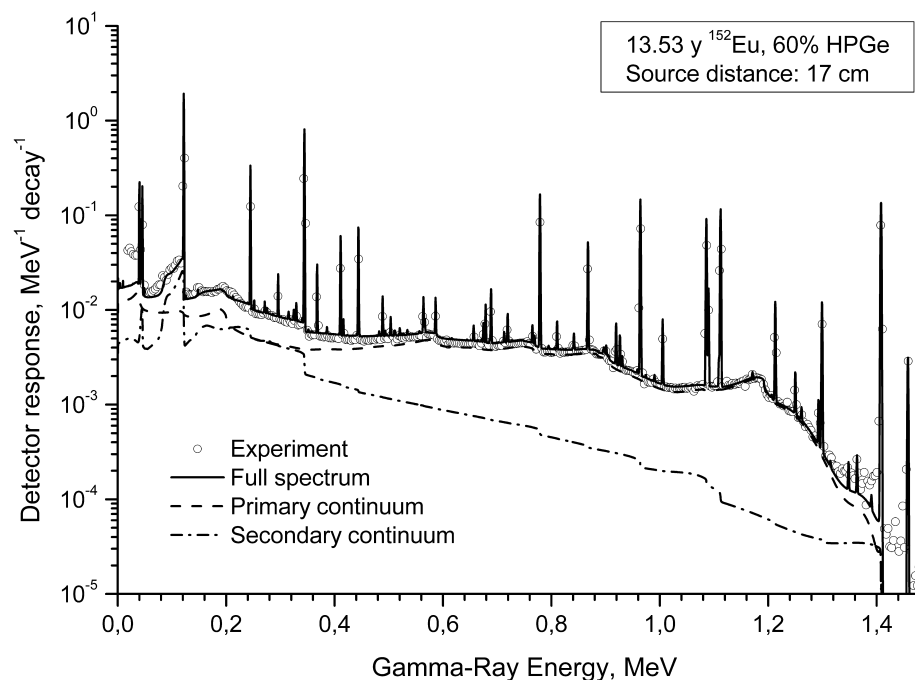
Measurement conditions: Center of experimental room



Results of the experimental validation with 60% HPGe coaxial detector

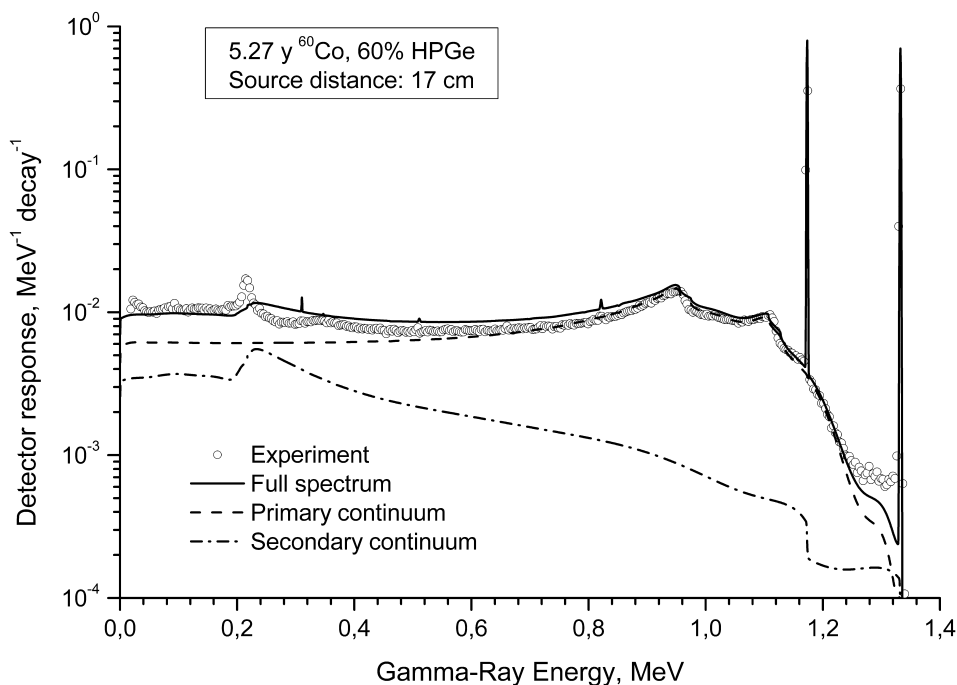


Full Energy Peak efficiency as a function of the photon energy: circles – experimental values, curve – calculated. Two sets of data refer to the source location at 5 cm and 17 cm distances from the detector end cap.

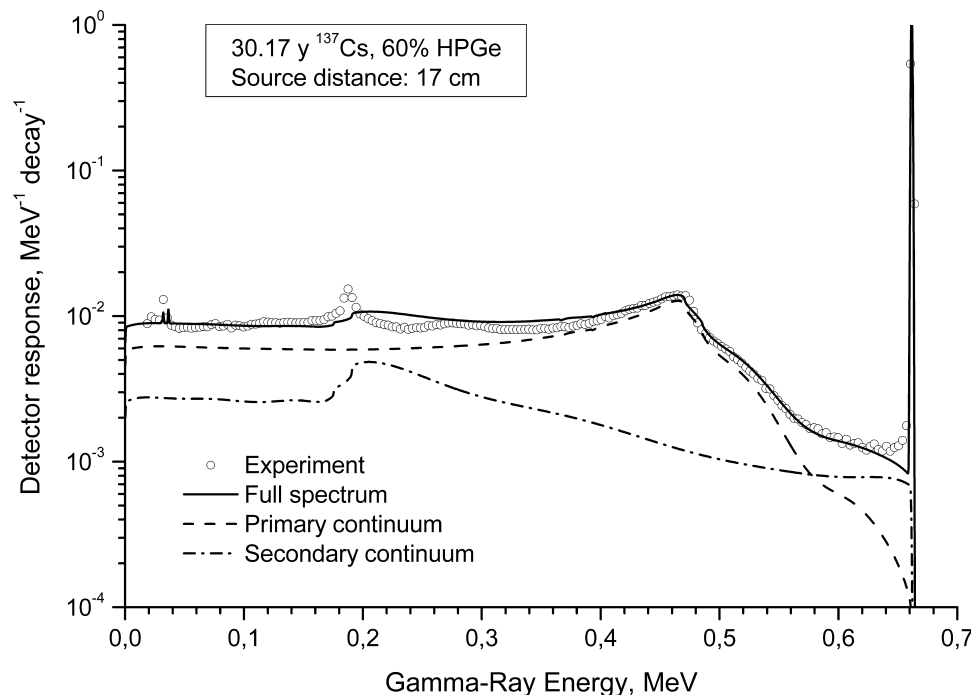


Calculated (curve) and experimental (circles) detector responses for ^{152}Eu source at 17 cm distance from the detector end cap.

Results of the experimental validation with 60% HPGe coaxial detector



Calculated (curve) and experimental (circles) detector responses for ^{60}Co source at 17 cm distance from the detector end cap.



Calculated (curve) and experimental (circles) detector responses for ^{137}Cs source at 17 cm distance from the detector end cap.

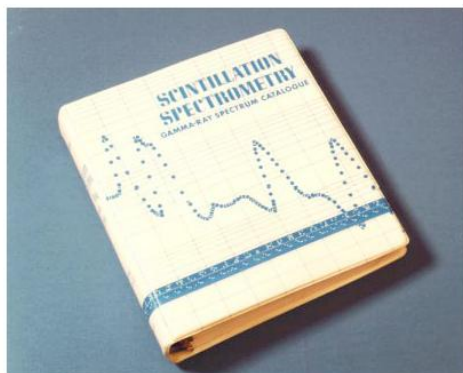
REVISED EDITION OF REPORT IDO - 16880 - 1
ORIGINAL ISSUED: AUGUST 1964
REV. ELECTRONIC UPDATE:: FEBRUARY 1997

SCINTILLATION SPECTROMETRY GAMMA-RAY SPECTRUM CATALOGUE

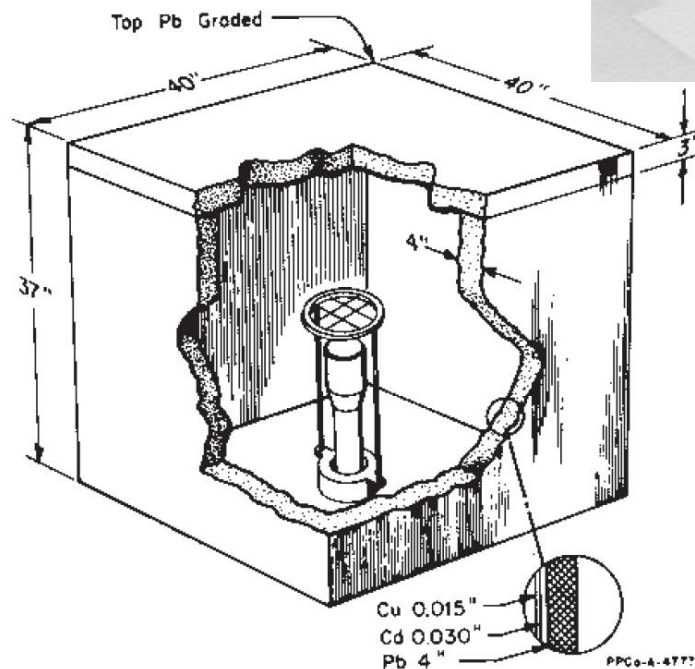
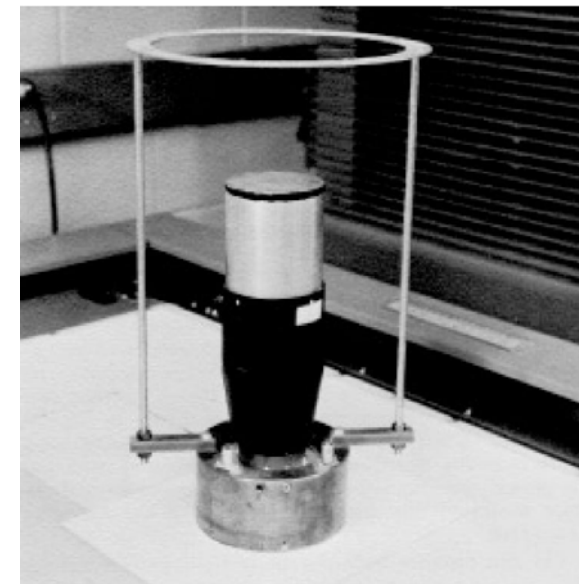
NEW VERSION OF 2ND EDITION
COMPILATION OF GAMMA-RAY SPECTRA
AND RELATED NUCLEAR DECAY DATA
VOLUME 1 OF 2

BY

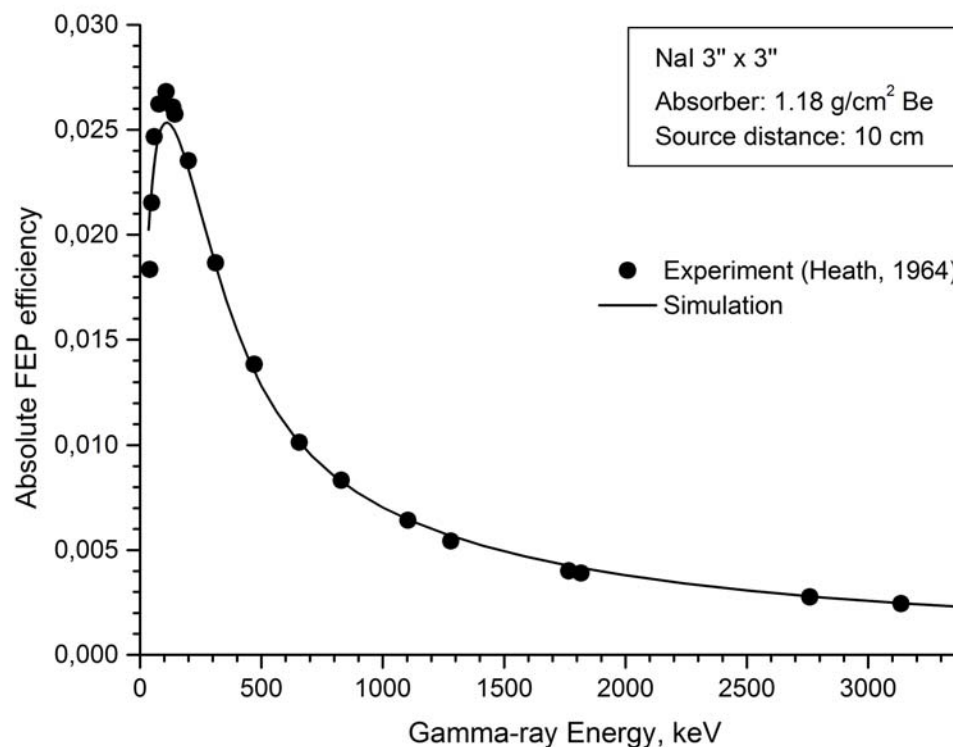
R. L. HEATH



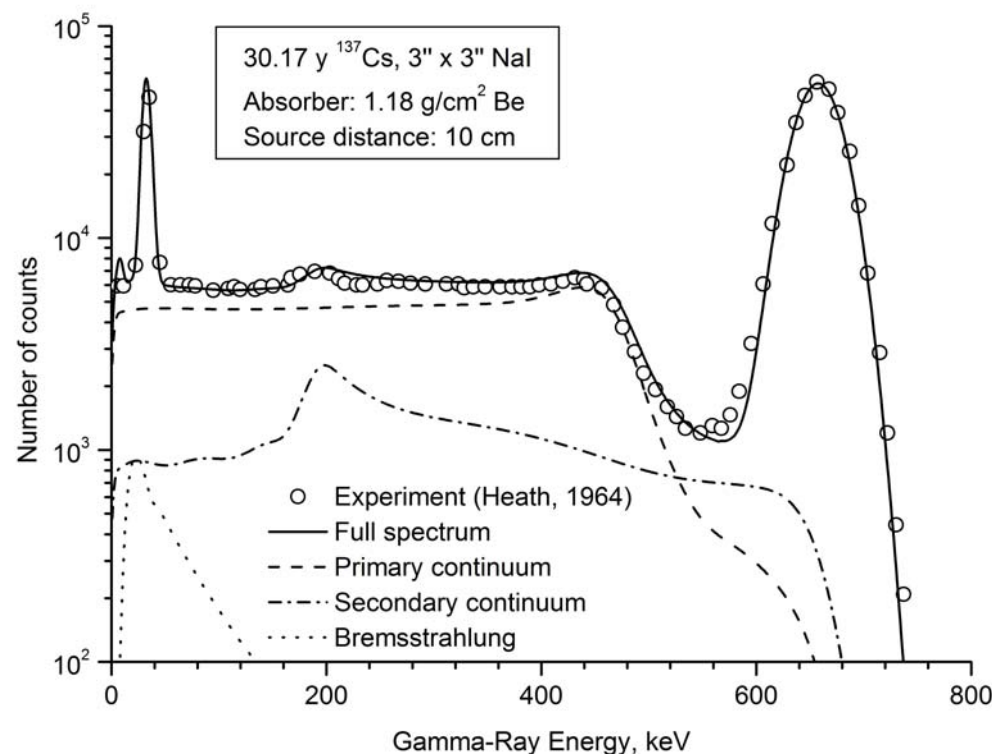
Detector:
3" × 3" NaI scintillation
detector



Results of the experimental validation with 3" × 3" NaI scintillation detector

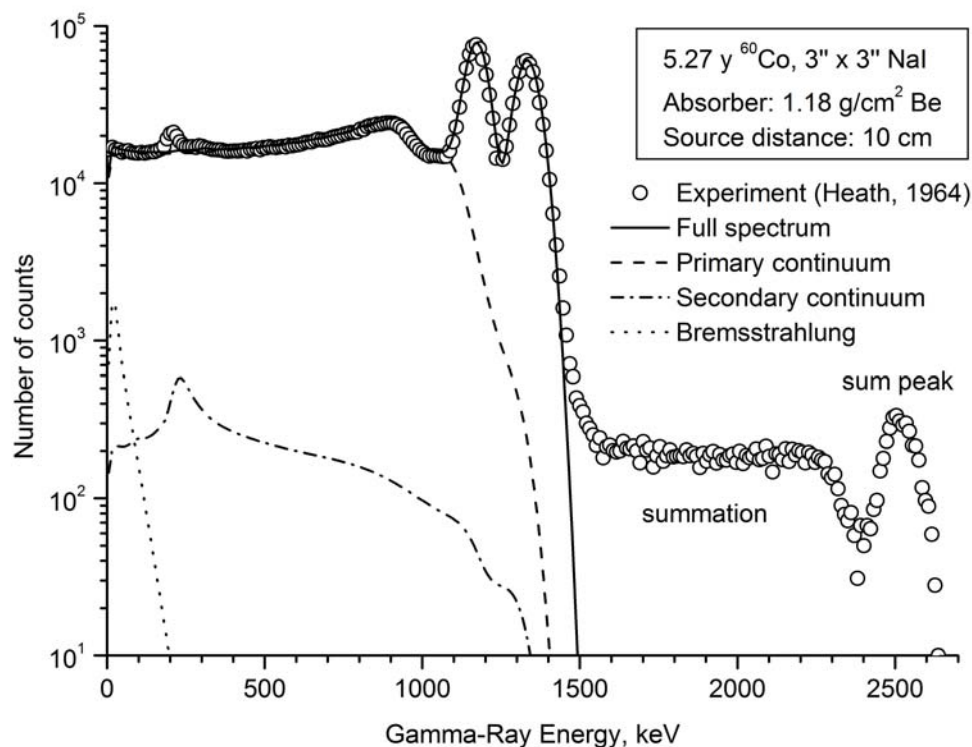


The simulated vs. experimental *FEP* efficiencies for a NaI 3" × 3" detector.

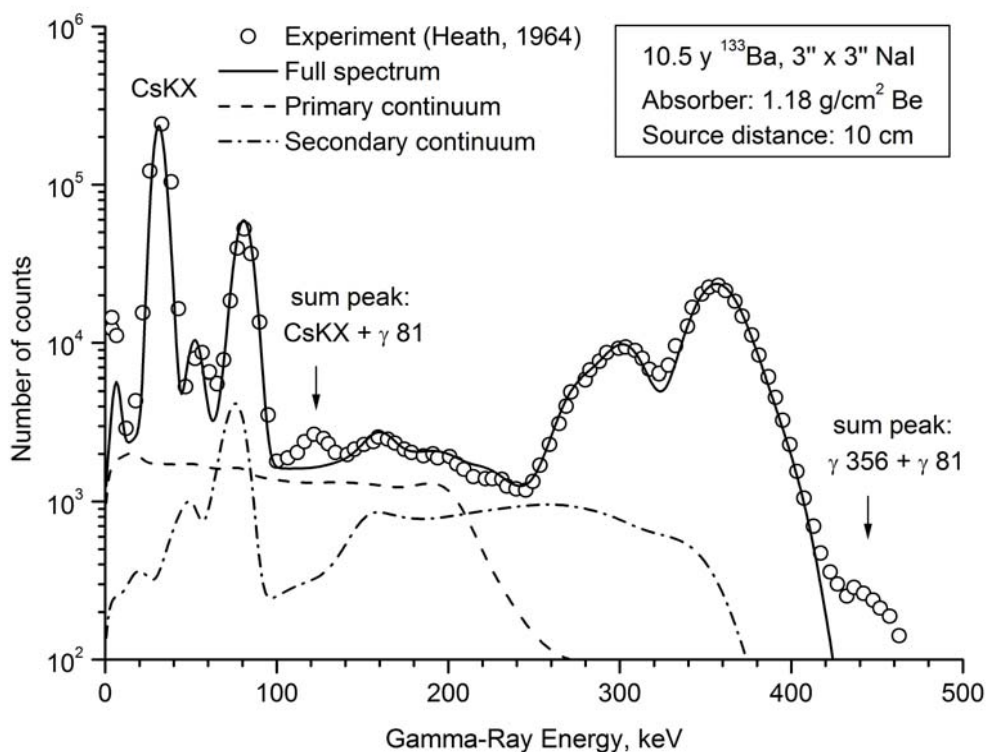


The experimental and simulated spectra for ¹³⁷Cs and a NaI 3" × 3" detector.

Results of the experimental validation with 3" × 3" NaI scintillation detector

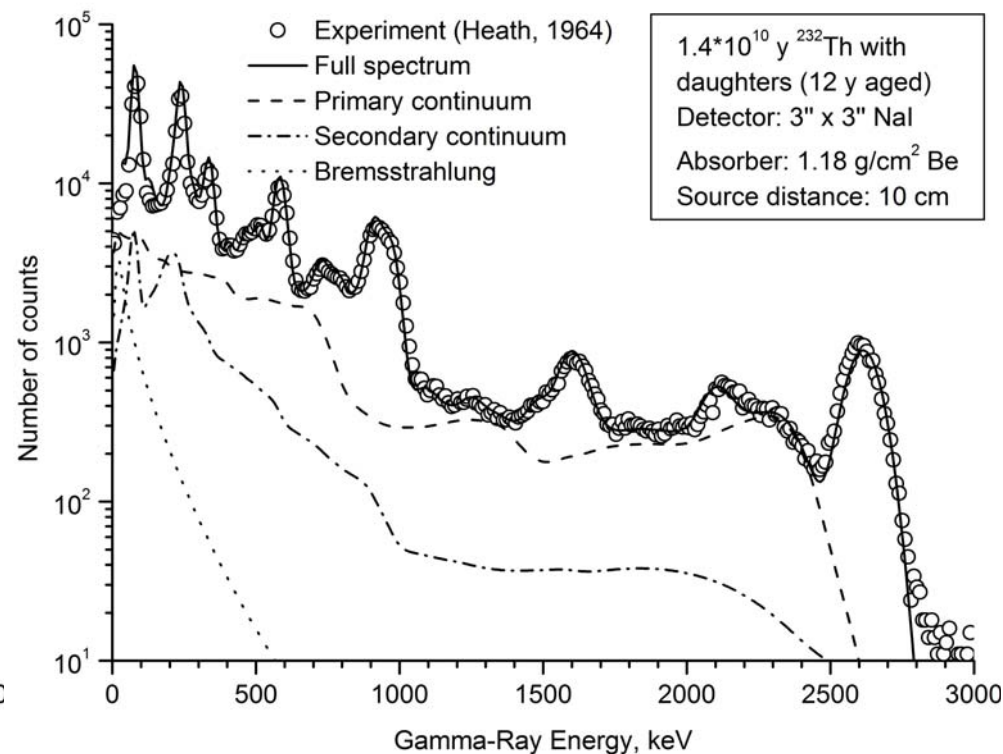
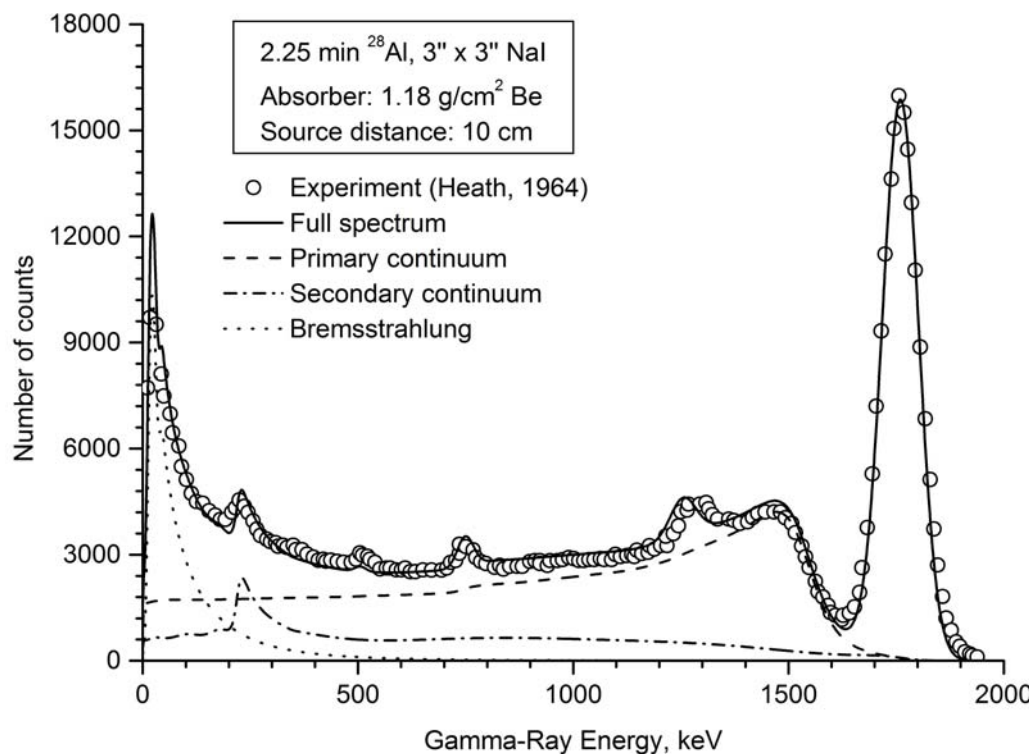


The experimental and simulated spectra for ^{60}Co and a NaI 3" × 3" detector.



The experimental and simulated spectra for ^{133}Ba and a NaI 3" × 3" detector.

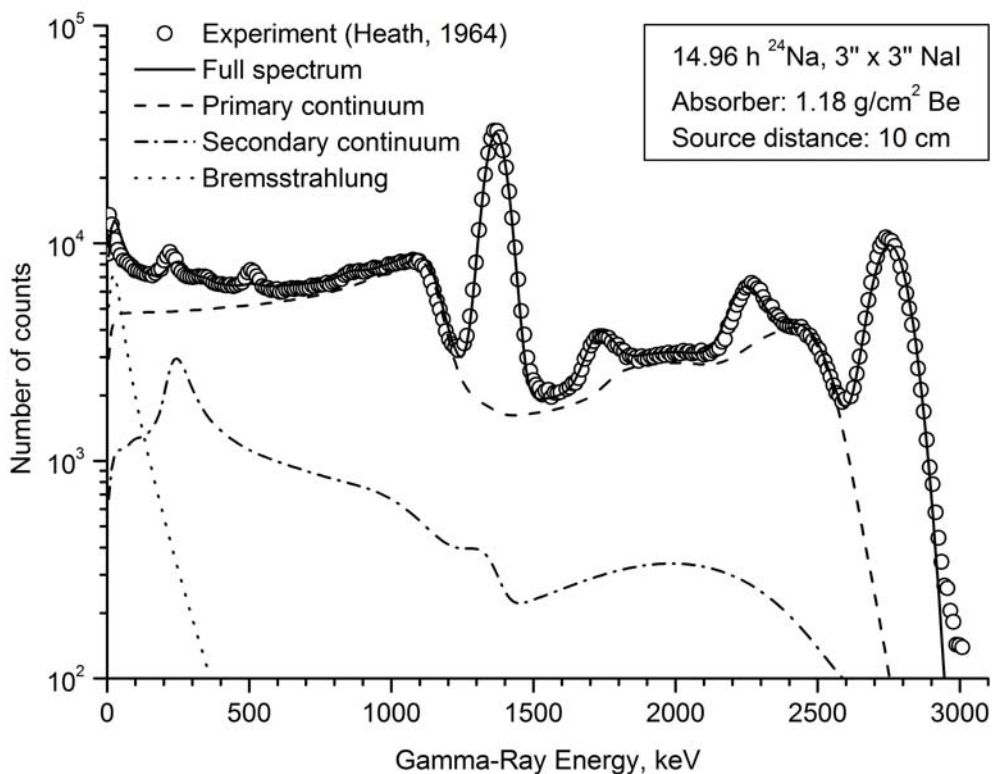
Results of the experimental validation with 3" × 3" NaI scintillation detector



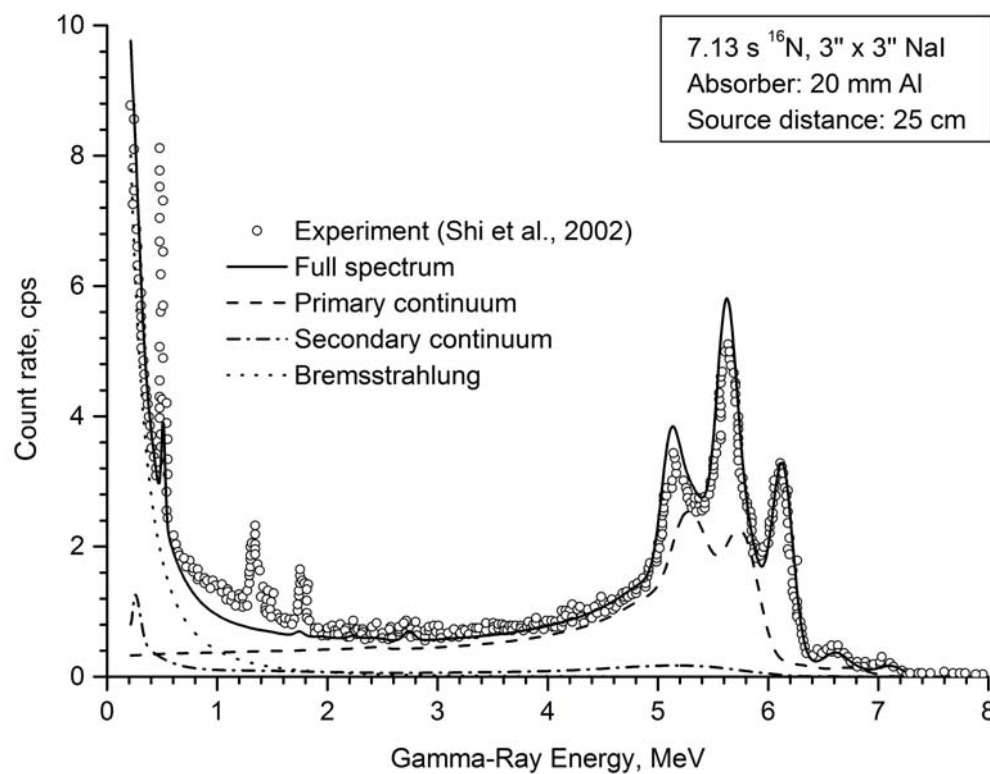
The experimental and simulated spectra for ^{28}Al and a NaI 3" × 3" detector .

The experimental and simulated spectra for a 12 year old ^{232}Th source and a NaI 3" × 3" detector.

Results of the experimental validation with 3" × 3" NaI scintillation detector

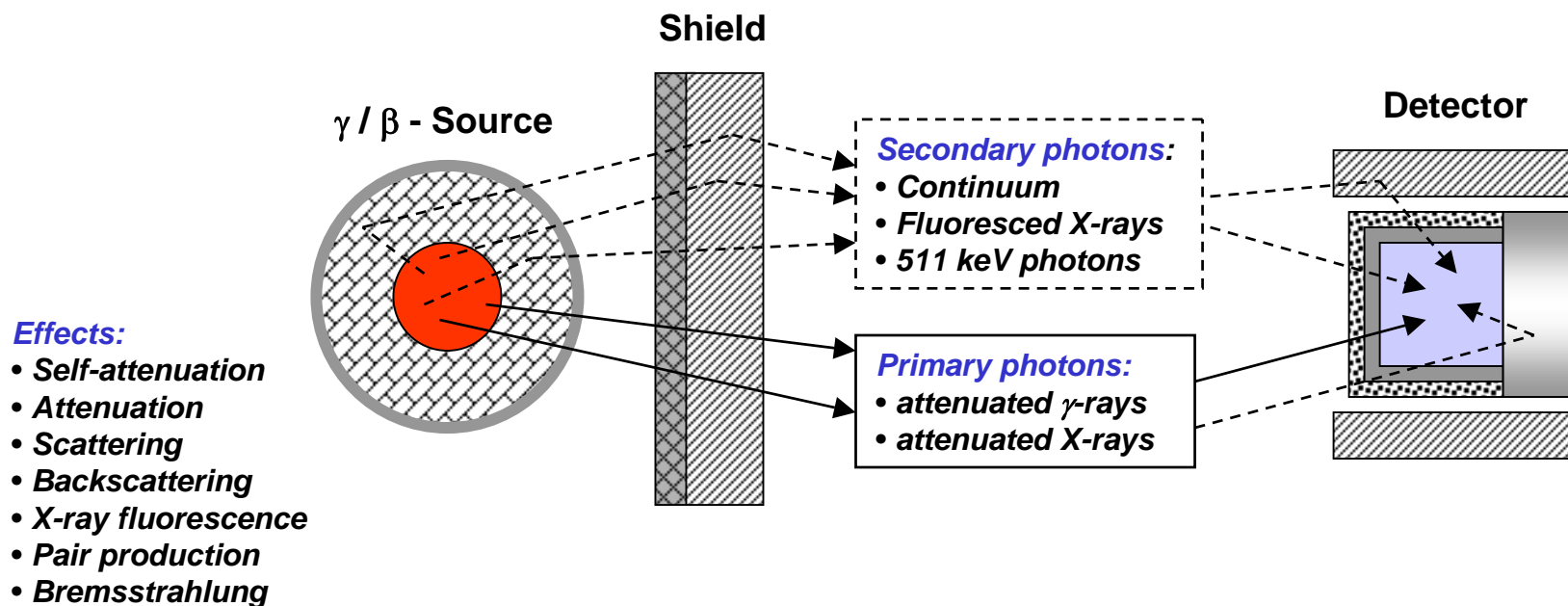


The experimental and simulated spectra for ^{24}Na and a NaI 3" × 3" detector.



The experimental and simulated spectra for ^{16}N and a NaI 3" × 3" detector.

Modelling γ -spectra from volume / shielded sources:

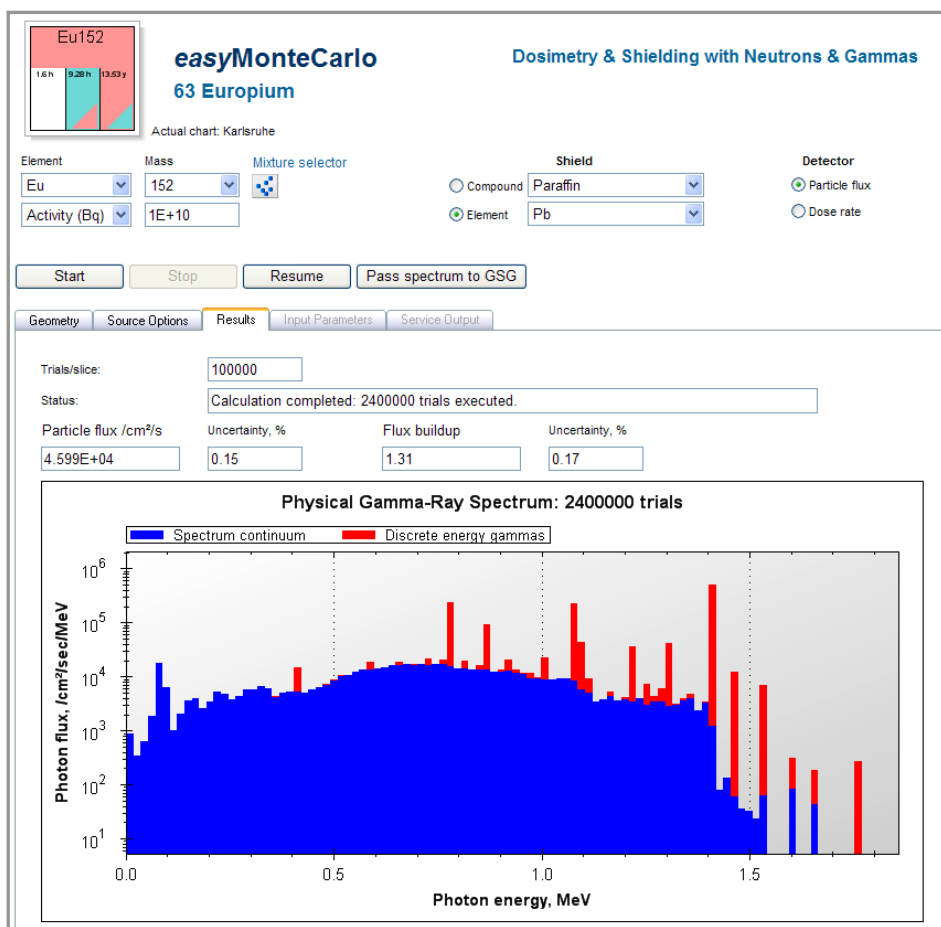


Challenges:

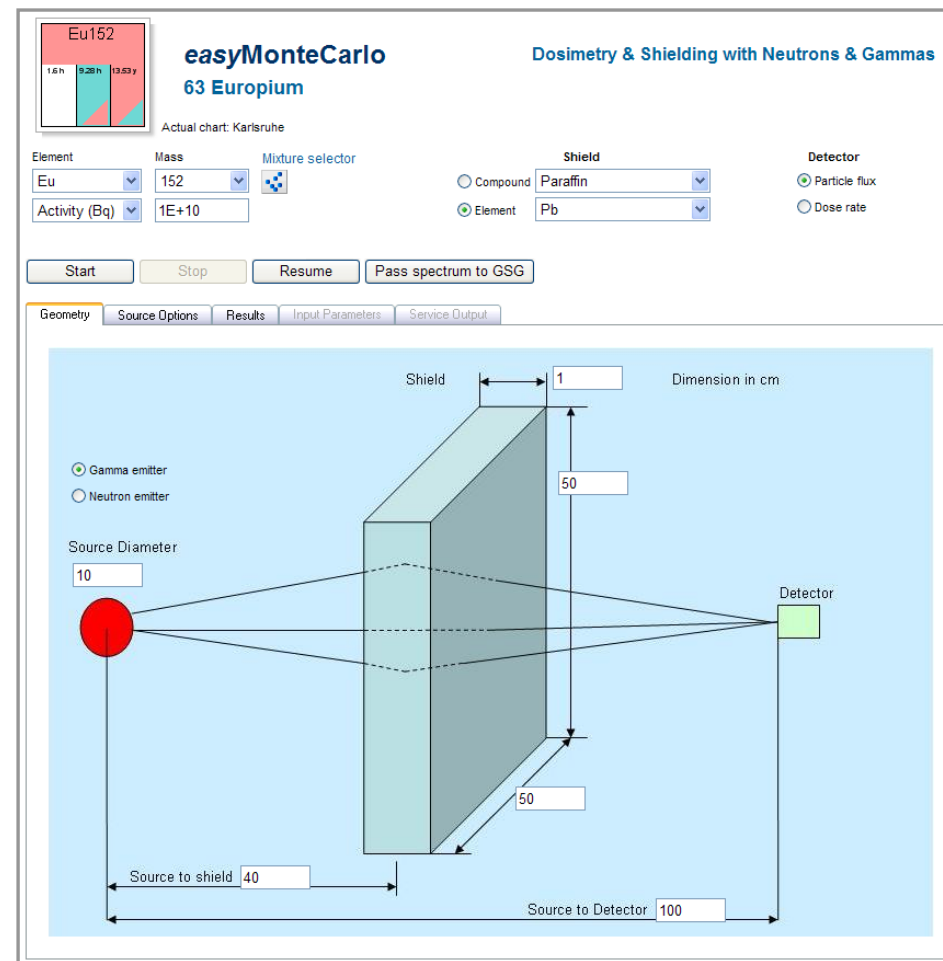
- an accurate reproduction of the incident photon flux properties is important;
- an accurate knowledge of the detector response in a broad energy range is required;
- a huge computational effort is normally needed.

What is the EasyMonteCarlo?

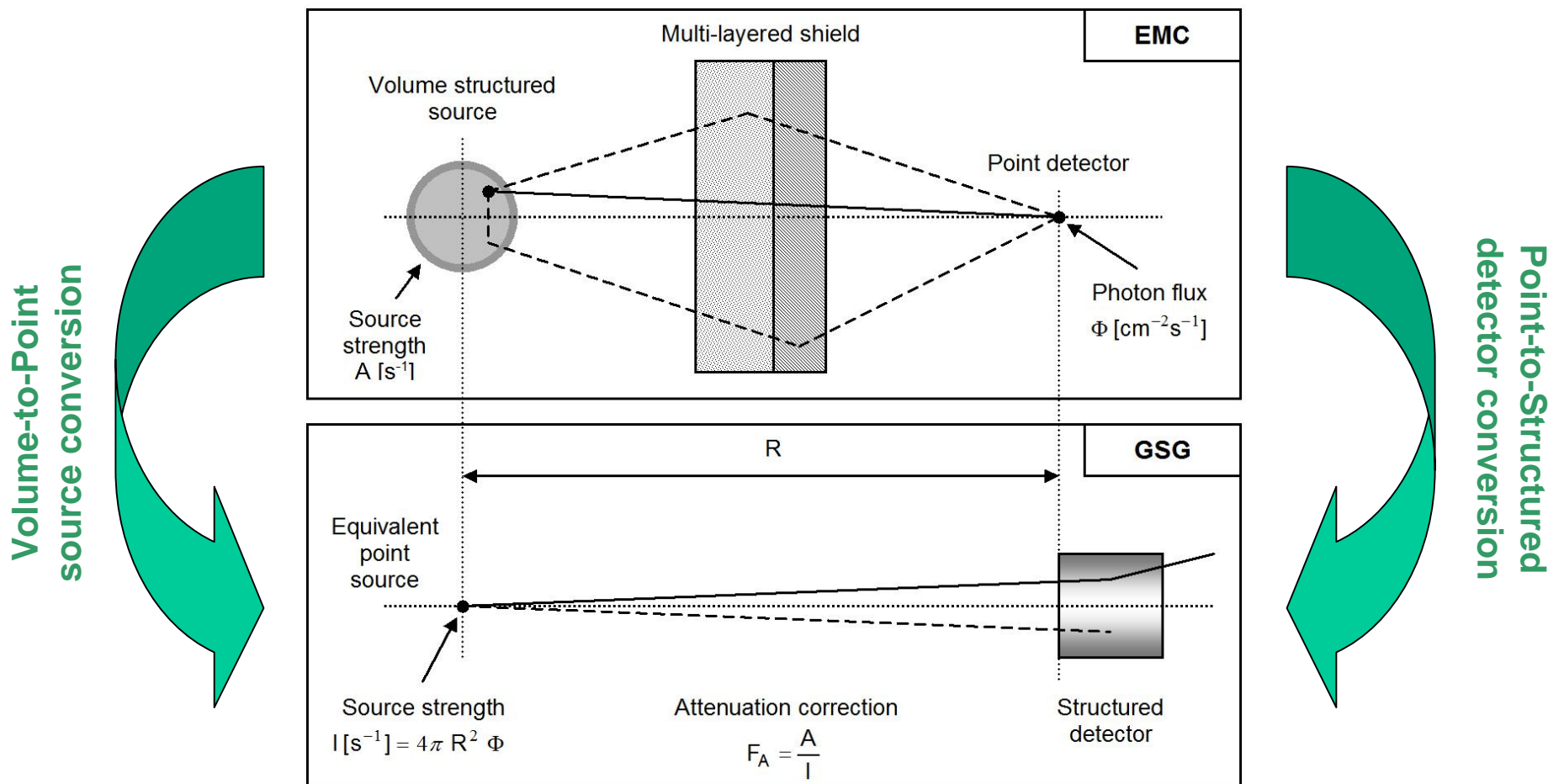
- A dedicated Monte Carlo **web-service**, i.e. a computational engine reachable to other programs via the Internet



EMC Front End:



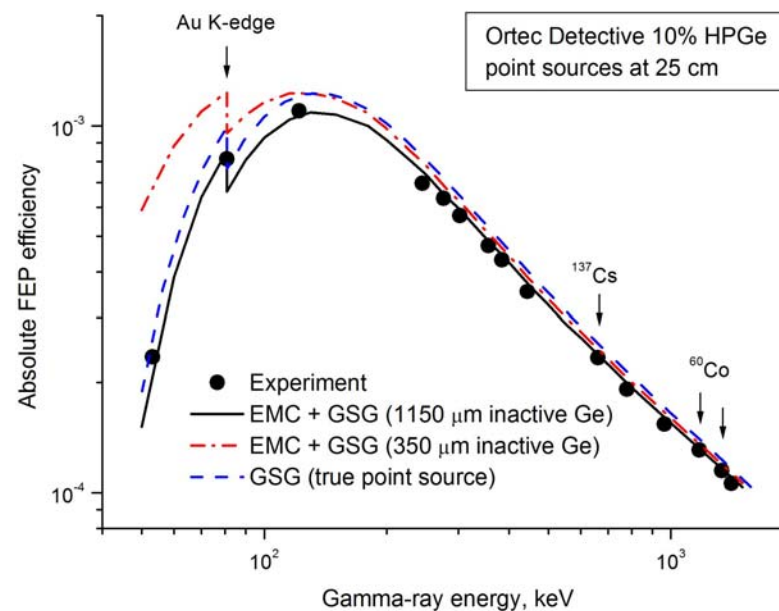
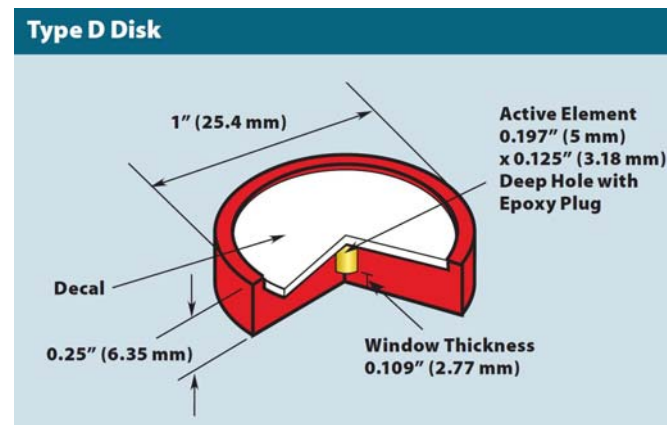
Coupled EMC / GSG calculations for volume & shielded sources:

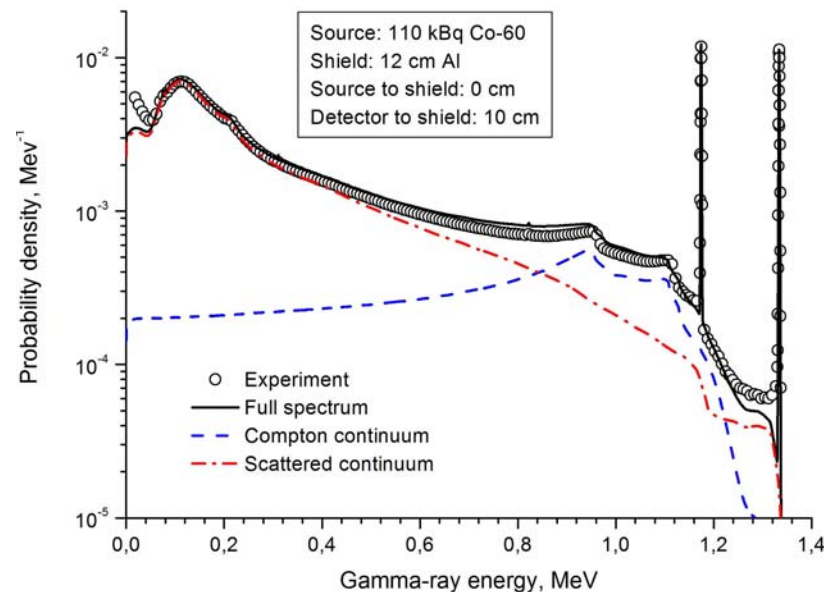
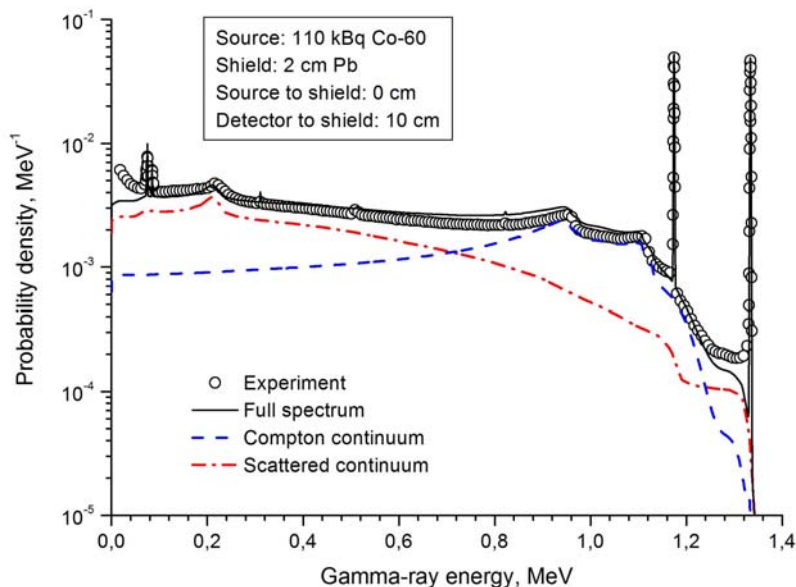
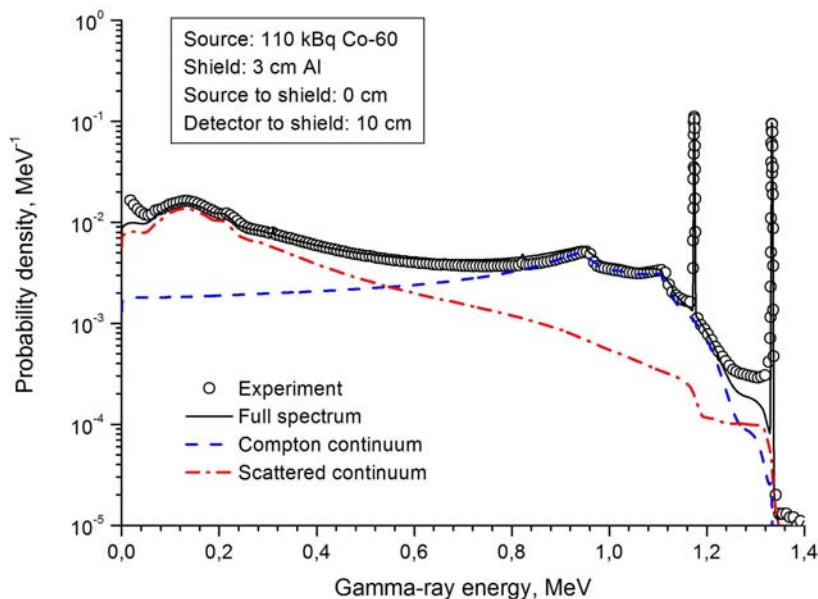
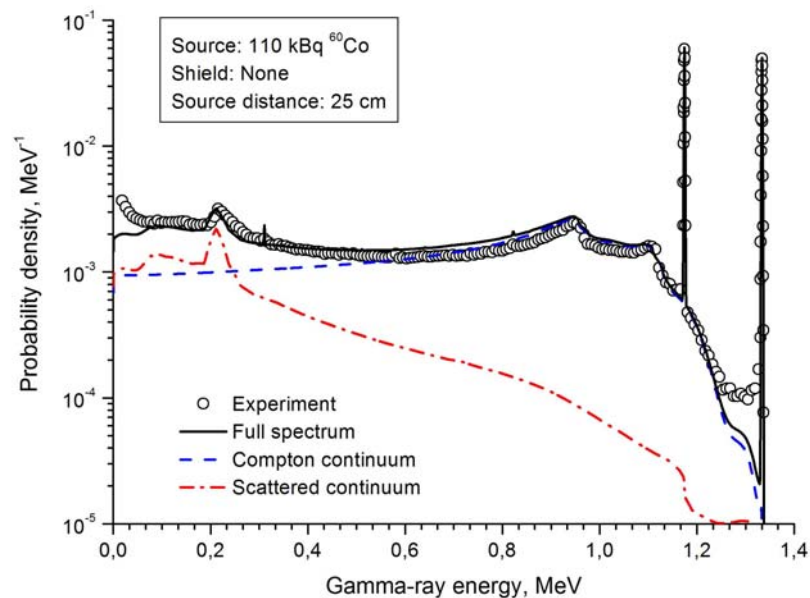




Experimental room: $L \times W \times H = 3.3 \times 3.8 \times 3.5 \text{ m}^3$.
Shields ($20 \times 20 \text{ cm}^2$): Pb (2 cm) and Al (3 cm, 12 cm).
Detector: 10% Ortec Detective, HPGe $\varnothing 50 \times 30 \text{ mm}$.
Shield to detector: 10 cm.
Source to shield: 0 cm.
Unshielded sources: at 25 cm distance.

Type D Disk source: Eckert & Ziegler Isotope Products, Reference & Calibration Sources, Product Information





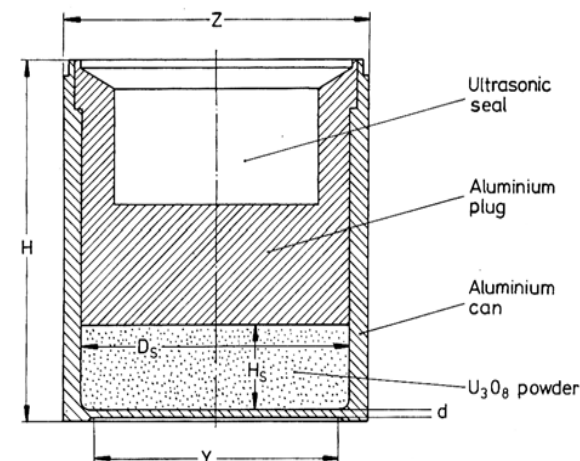


Experimental room: $L \times W \times H = 3.3 \times 3.8 \times 3.5 \text{ m}^3$.
Shields ($20 \times 20 \text{ cm}^2$): Pb (2 cm) and Al (3 cm, 12 cm).
Detector: 10% Ortec Detective, HPGe $\varnothing 50 \times 30 \text{ mm}$.
Shield to detector: 10 cm.
Source to shield: 0 cm.
Unshielded source: at 10 cm distance.

CBNM-446 Uranium:

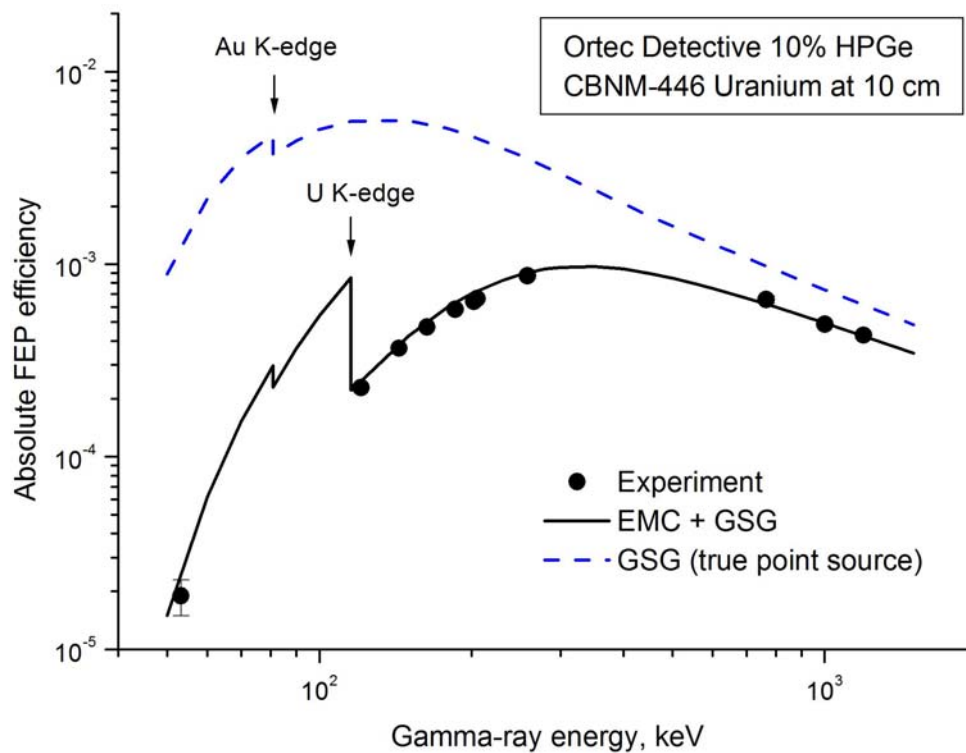
Separation date: 1979
 U_3O_8 , 200 g, 3.3 g/cm^3
 Capsule: $\varnothing 8 \times 9 \text{ cm}$
 Sample: $\varnothing 7 \times 1.58 \text{ cm}$
 Al window: 0.2 cm

^{232}U – 4.1 ppt
 ^{234}U – 0.0359 wt %
 ^{235}U – 4.4623 wt %
 ^{236}U – 0.0068 wt %
 ^{238}U – 95.495 wt %



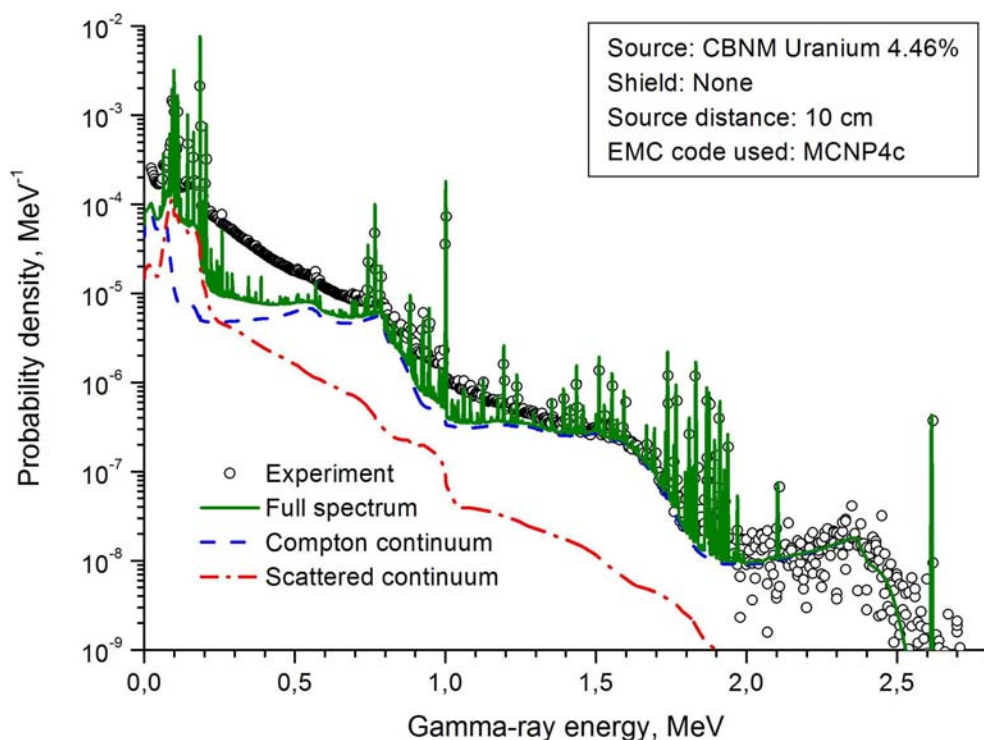
Nuclide	Activity	Nuclide	Activity
^{234}U	14.1 MBq	^{219}Rn	128 Bq
^{238}U	2.02 MBq	^{211}Pb	128 Bq
$^{234\text{m}}\text{Pa}$	2.02 MBq	^{211}Bi	128 Bq
^{234}Pa	3.03 kBq	^{212}Pb	438 Bq
^{234}Th	2.02 MBq	^{212}Bi	438 Bq
^{235}U	607 kBq	^{224}Ra	438 Bq
^{231}Th	607 kBq	^{208}Tl	157 Bq
^{231}Pa	372 kBq	Total	21.4 MBq

Unshielded CBNM-446: FEP efficiency

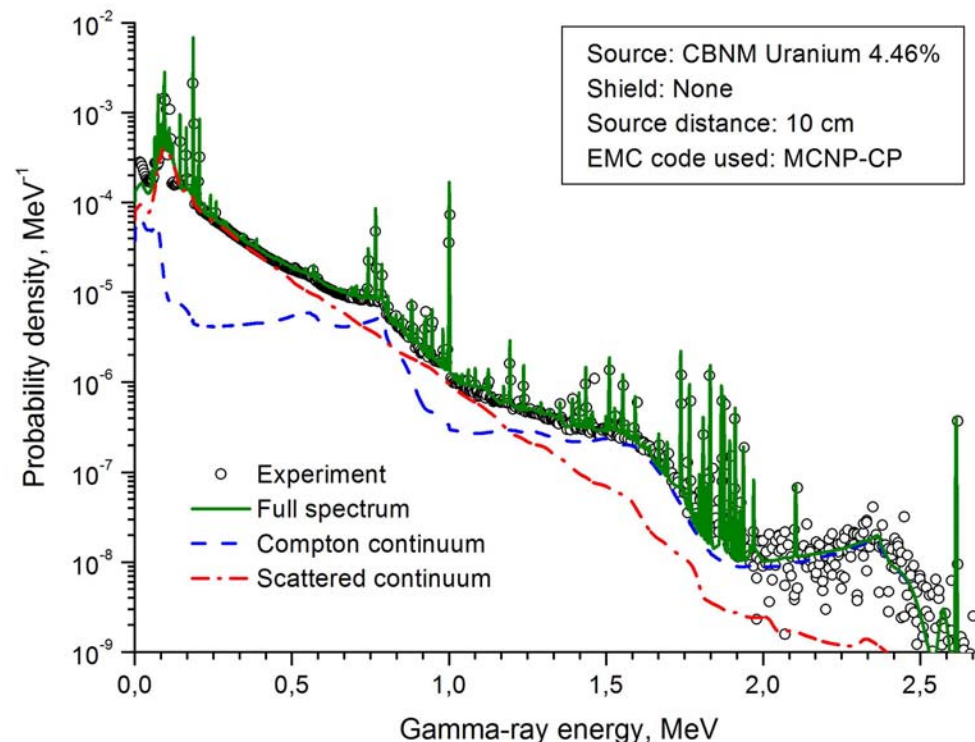


Unshielded CBNM-446

EMC option: MCNP4c

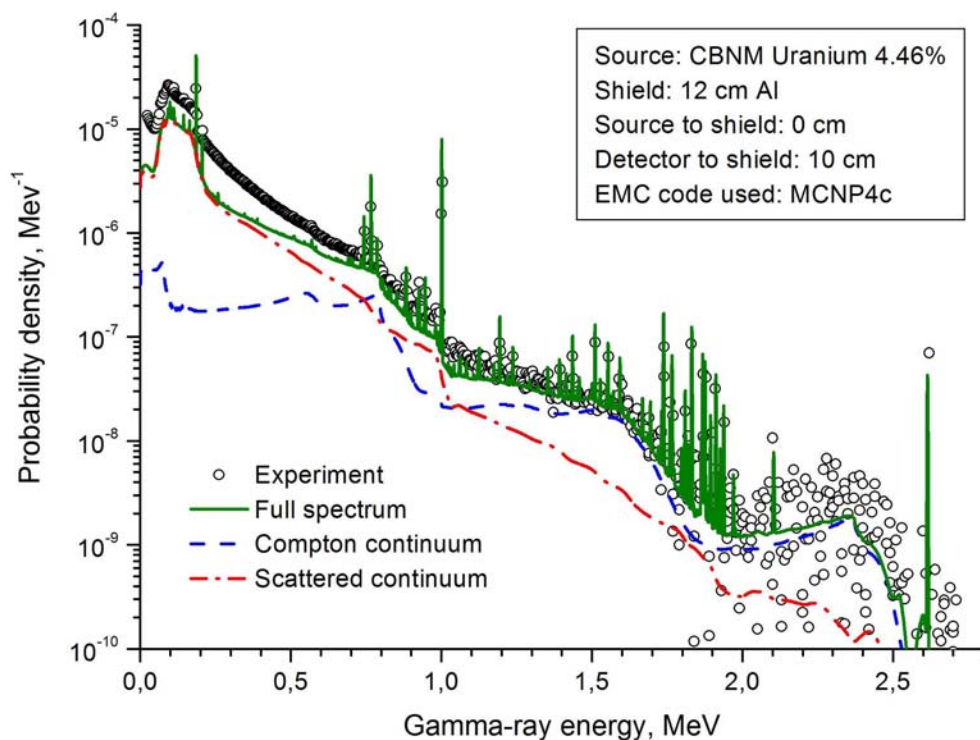


EMC option: MCNP-CP

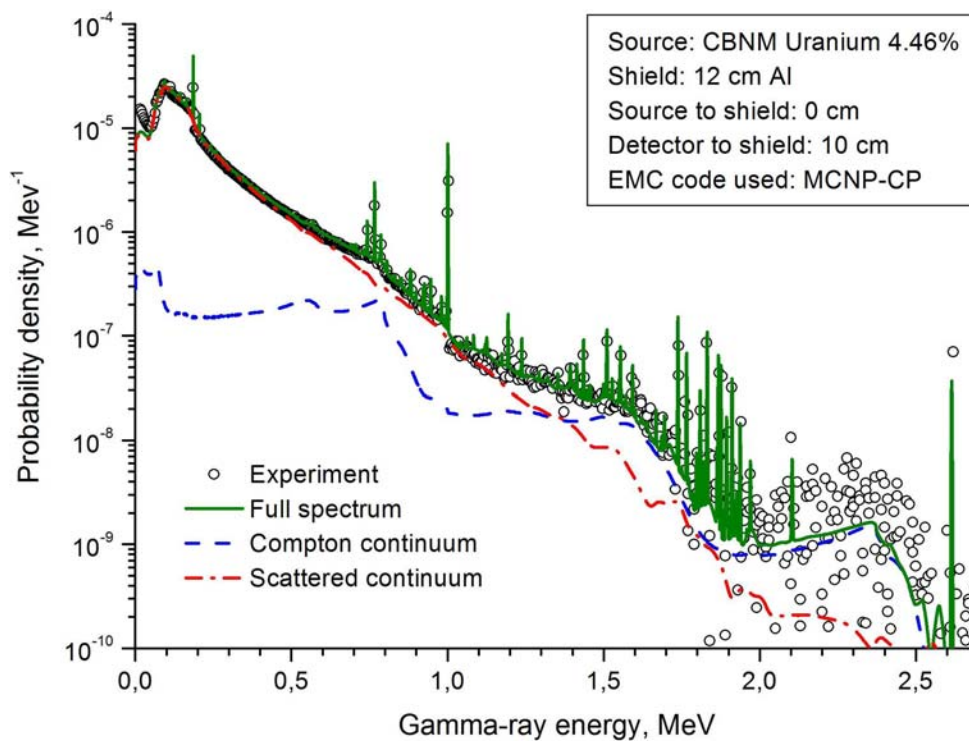


CBNM-446 shielded with 12 cm Al

EMC option: MCNP4c

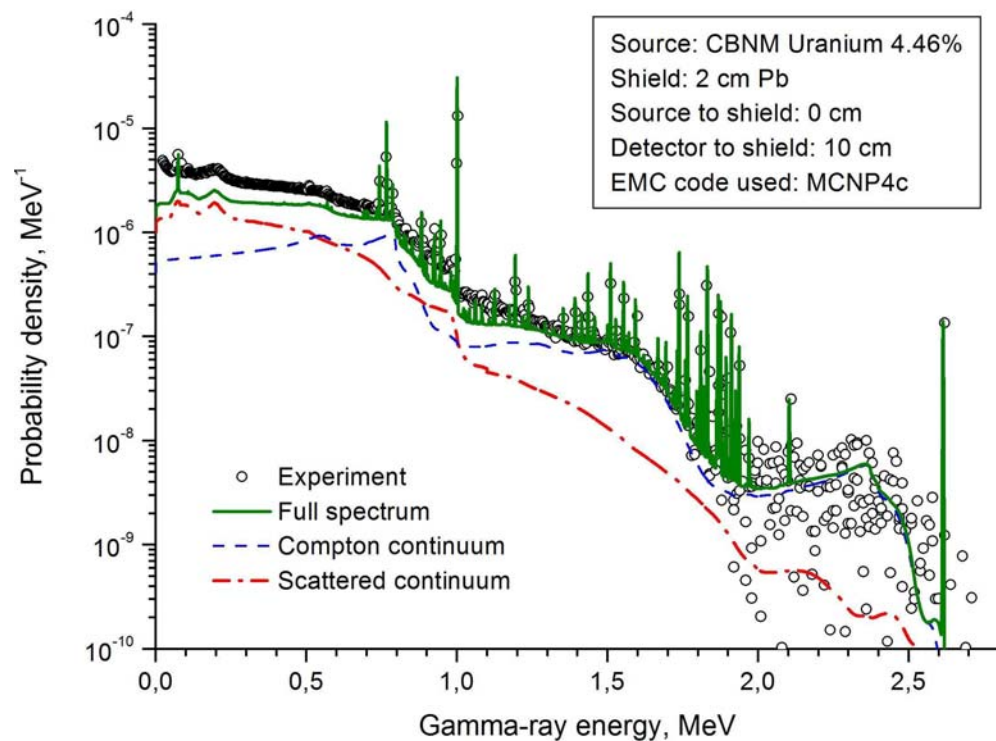


EMC option: MCNP-CP

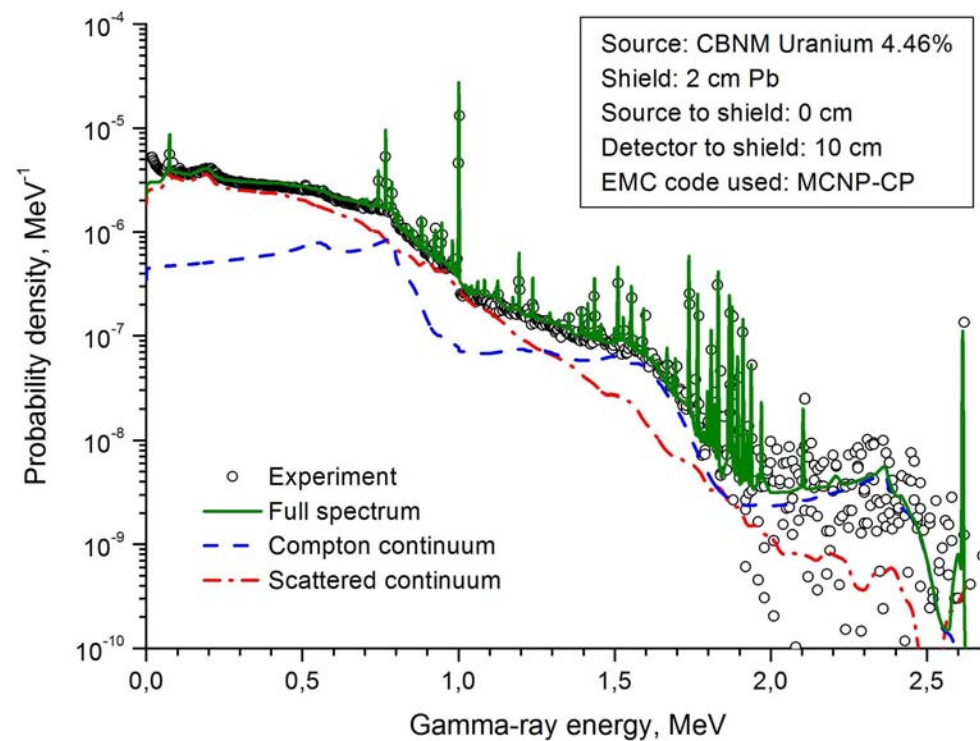


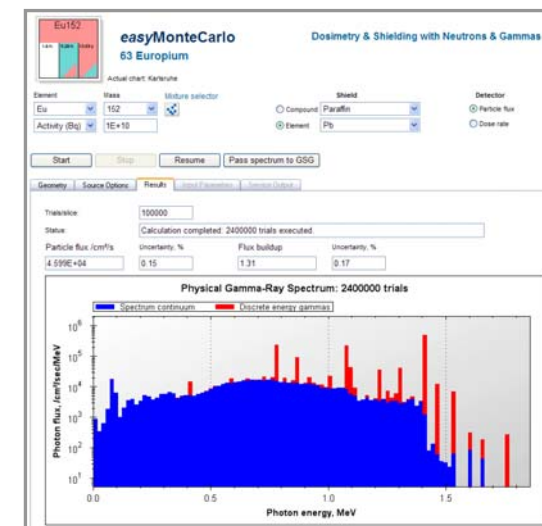
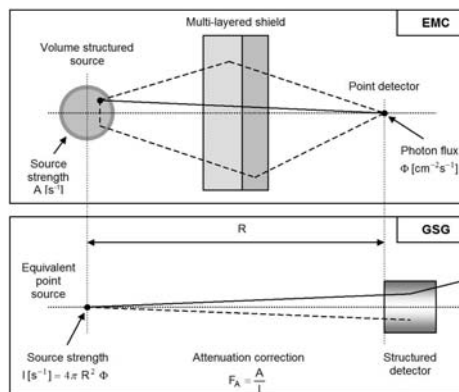
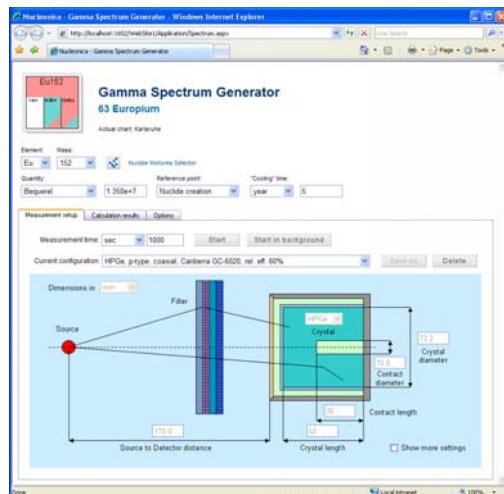
CBNM-446 shielded with 2 cm Pb

EMC option: MCNP4c



EMC option: MCNP-CP





Thank you for your attention !

